

BROOKHAVEN NATIONAL LABORATORY Safety & Health Services Division INDUSTRIAL HYGIENE GROUP Standard Operating Procedure: Program Procedure	NUMBER IH71200
	REVISION FINAL Rev0
Subject: Personal Protective Equipment (PPE) Selection for Non-Radiological Chemical Hazards	DATE 09/05/07
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1.0 PURPOSE & SCOPE

Purpose: This document sets the policy of the Safety & Health Services Division (SHSD) Industrial Hygiene (IH) group for selecting Personal Protective Equipment (PPE) for Chemical hazard (i.e. Chemical Protective Clothing (CPC)). This process is used in the selection of the adequate glove and suit material as part of an effective PPE program. This SOP is to be used in conjunction with the BNL Subject Areas: Personal Protective Equipment and Chemicals, Working with.

The program complies with OSHA 29CFR1910.132 (*PPE General requirements*) and 29CFR1910.138 (*Hand Protection*). It uses *ANSI ISEA 105-2005* as a reference.

This document describes a procedure for selecting the most appropriate CPC by considering available equipment options and the hazard and severity of surface and airborne non-radiological contaminants present in the workplace. The goal of the procedure is to provide a uniform methodology in selecting equipment to provide protection to workers using the CPC.

Scope: The scope of this SOP is for chemical hazards (such as dusts, fumes, mists, and vapors, lead, toxic metals, and asbestos). It is limited to glove and chemical impervious suit selection. It is not intended or approved for use in selecting radiological hazards CPC. When exposure is to both radiological and non-radiological hazards, the IH must work together with the radiological control facility support representative to determine the combined CPC.

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2.0 RESPONSIBILITIES

- 2.1 This program is implemented through the SHSD Industrial Hygiene Group.
- 2.2 Members of the SHSD Industrial Hygiene Group and other BNL organizations, with qualifications meeting Section 7 of this procedure, follow this document in the PPE selection process. It is the responsibility of persons selecting CPC to comply with all provisions in the BNL *PPE* and *Chemicals, Working with Subject Areas* and this SOP.
- 2.3 **Hazard Analysis during selection of PPE:** It is the responsibility of persons selecting CPC to:
 - 2.3.1 Use the appropriate personal protective equipment while performing field evaluations of the work process, when needed.
 - 2.3.2 Obtain all required training and qualification for hazards present in areas where field evaluations will be done (such as lead, asbestos, chemicals, or radioactive contamination).
 - 2.3.3 Comply with all work planning and work permit system requirements when entering areas to obtain information to select the correct CPC.
- 2.4 The person using this procedure is responsible to ensure that information they provide on CPC selection is integrated into the work planning documentation for the work being done.

3.0 DEFINITIONS

Break through Time: the time, after the onset of challenge of a chemical to a glove/suit, when the chemical permeates through the inner layer of the glove/suit.

Degradation: A deleterious change in one or more properties of a glove due to contact with a chemical. Rubber gloves may swell, soften and weaken; plastic gloves may shrink, stiffen, and crack when flexed.

Dexterity: the ability of the wearer to manipulate objects and control his or her hands in the desired manner.

Chemical Hazard Types

Dust: An aerosol consisting of mechanically produced solid particles derived from the breaking up of larger particles. Dusts generally have a larger particle size when compared to fumes.

Fumes: Solid aerosols formed by condensation of a gas or vapor. Fumes generally have a smaller particle size than dusts.

Gas: The gaseous phase of matter that normally exists in a gaseous state at room temperature

Mist: An aerosol composed of liquid particles.

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Vapor: The gaseous phase of matter that normally exists in a liquid or solid state at room temperature.

Grip: the ability of the glove wearer to exert pressure on an object when holding it.

Occupational Exposure Limit (OEL): The lower of ACGIH TLV®, Ceiling, STEL® or OSHA PEL.

Penetration: *The flow of a chemical through zippers, stitched seams, pinholes, or other imperfections in chemical protective clothing on a non-molecular level.*

Permeation: The flow of a chemical through the barrier layer of a glove/suit on a molecular level. This process involves: absorption of the chemical onto and into the outside of the glove/suit; diffusion of the chemical through the glove/suit (as individual molecules pass between molecules of the glove film); and desorption of the chemical inside the glove/suit.

Qualified Selector: A person who has demonstrated competency, in accordance with Section 7, to perform this procedure.

Tactility: the ability of the glove wearer to sense objects by touch.

4.0 PREREQUISITES

- 4.1 **Qualifications:** See Section 7 *Implementation and Training*. Do not perform work using this procedure without meeting that Section's training and qualification requirements.

5.0 PRECAUTIONS

- 5.1 **Chemical Protective Clothing (CPC):** The CPC selection process does not in itself expose the selector to any hazard. Personal protective equipment is not required unless needed to enter hazardous areas to observe workplace conditions.
- 5.2 **Hazard Determination:** The CPC selection process may be done areas where hazards (such as lead, asbestos, chemicals, or radioactive contamination) may be present. Use appropriate PPE.
- 5.3 **Work Planning:** All requirements of the work planning system reviews must be met in performing this procedure.
- 5.4 **Job Risk Assessment:** Consult the *Job Risk Assessment* for the risk analysis of this operation based on the hazards and controls:

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- [SHSD-JRA-05](#) for the field review portions of this SOP and
- [SHSD-JRA-14](#) for the Administrative portion of the SOP.

5.5 **Environmental Impact and Waste Disposal:** This technique does not have adverse impact on the environment. No waste or environmental contamination is generated in this process.

6.0 PROCEDURE

- 6.1 **Determine the airborne and surface level concentration:** Measure or calculate the maximum expected workplace concentration of contaminants by measurement by:
- 6.1.1 NIOSH, OSHA, or EPA approved integrated sampling methodology, or
 - 6.1.2 Calculation of maximum concentration based on use rate and atmospheric conditions.

Follow accepted methodology described in SHSD IH Group SOPs for surface wipe sampling and integrated sampling collection, processing (chain of custody) and exposure analysis. Because activities in the work area may vary during the shift and hazard concentrations could change, the monitoring should include the period of highest probable exposure conditions possible throughout a full work shift.

- 6.2 Consider the physical, chemical, and toxicological properties of the contaminant(s) including: physical state (gas, vapor, particulate/dust, fume, and mist), including: atmospheres immediately dangerous to life and health; combination of hazard classes; odor threshold and warning properties.
- 6.3 **Selection of CPC elastomer:** Considering the properties of the contaminants, select the acceptable CPC material(s) based on the capabilities, limitations, and ability of the CPC to protect against:
- Permeation,
 - Penetration, and
 - Degradation.
- Use the information sources listed in the reference section to determine with CPC materials are acceptable.

- 6.4 Consider the physical, environmental, and chemical use conditions at the work area when specifying CPC. Select the best choice from the available CPC elastomers and PPE styles considering the following:

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- Duration of contact with the chemical,
 - Worker activity: Continuous or intermittent work; light, medium, or heavy work,
 - Frequency of use: Routine, non-routine, emergency or rescue use,
 - The ability to move in the CPC, especially impact on the escape of workers if an emergency occurs and access of rescue operations,
 - The person's ability to wear or use the equipment and negative impact of the equipment on the operation,
 - Ensure all hazards are covered such as physical hazards including sharp edges. It may be necessary to require both chemical protective and physical hazards together (eg. nitrile disposable under leather gloves),
 - Consider the length of time between uses for disposal purposes. (eg. Will the CPC be stored without full decontamination awaiting the next use? The chemicals already present will continue to permeate the glove material.)
- 6.5 When multiple contaminants are present, unless information on the mixture is available, select the equipment based on protection for the most hazardous contaminant. However, protection must be provided for exposure to all anticipated hazardous contaminants.
- 6.6 Document the equipment selection on the *PPE Selection Form* located in the BNL SBMS Subject Area: Personal Protective Equipment: *Protective Clothing Selection Form*.

7.0 IMPLEMENTATION AND TRAINING

- 7.1 For all BNL personnel, the IH Group Leader shall set the qualification criteria of SHSD persons to select non-radiological equipment. CPC selection shall be performed by persons who have demonstrated the competence to satisfactorily perform the tests as evidenced by experience and training. All persons must have met the qualification criteria set in IH50300 *BNL IH Program and IH Group Training & Qualification Matrix* and the specific criteria in 7.2.
- 7.2 The qualification criteria for a use of this SOP are:
- 7.2.1 An overall knowledge of CPC principles and completion of the BNL web course (or equivalent) in CPC – Chemical Protective Clothing User Training HP-OSH-157.
 - 7.2.2 Specific knowledge of this procedure and OSHA 29CFR1910.132 & 138.

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- 7.2.3 The documentation of personnel qualification is to be made on Attachment
9.3. The re-qualification period is three years.

8.0 REFERENCES

- 8.1 BNL SBMS Subject Area: [*Personal Protective Equipment*](#)
- 8.2 BNL SBMS Subject Area Personal Protective Equipment: [*Exhibit: BNL Handbook on Personal Protective Equipment \(PPE\) Selection and Use*](#)
- 8.3 Occupational Safety and Health Administration, OSHA 29CFR1910.132 *PPE General Requirements.*
- 8.4 Occupational Safety and Health Administration, OSHA 29CFR1910.138 *Hand Protection.*
- 8.5 Occupational Safety and Health Administration, OSHA 29CFR1910.120 Hazardous Operations and Emergency Response.
- 8.6 American National Standard Institute (ANSI) ISEA 105-2005: *American National Standard for Hand Protection Selection Criteria.*
- 8.7 National Institute for Occupational Safety and Health, NIOSH PPE Decision Logic DHHS/NIOSH Publication No. 97-108.
- 8.8 K. Forsberg, S. Mansdorf; *Quick Selection Guide to Chemical Protective Clothing*, 4th Edition, 2007, Van Nostrand Reinhold.

9.0 ATTACHMENTS

- 9.1 *Recommended Glove Material for common BNL laboratory chemicals*
- 9.2 *Sample of Online NIOSH Pocket Guide to Chemical Hazards*
- 9.3 *SHSD Non-Radiological PPE Qualification record*

10.0 DOCUMENTATION

Document Development and Revision Control Tracking		
Prepared By: <i>(signature/date on file)</i> R. Selvey 03/14/07 Certified Industrial Hygienist	Reviewed By / Date: <i>(signature/date on file)</i> John Peters 09/05/07 Certified Industrial Hygienist	Approved By / Date: <i>(signature/date on file)</i> R. Selvey 09/05/07 Industrial Hygienist Group Leader
ESH Coordinator/ Date: <i>none</i>	Work Coordinator/ Date: <i>none</i>	SHSD Manager / Date <i>none</i>

The only official copy is on-line at the SHSD IH Group website.
Before using a printed copy, verify that it is current by checking the document issue date on the website.

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QA Representative / Date: <i>none</i>	Training Coordinator / Date: <i>none</i>	Filing Code: IH52
Facility Support Rep. / Date: <i>None</i>	Environ. Compliance Rep. / Date: <i>none</i>	Effective Date: 09/05/07
ISM Review - Hazard Categorization <input type="checkbox"/> High <input type="checkbox"/> Moderate <input checked="" type="checkbox"/> Low/Skill of the craft	Validation: <input type="checkbox"/> Formal Walkthrough <input checked="" type="checkbox"/> Desk Top Review <input type="checkbox"/> SME Review Name / Date:	Implementation: Training Completed: Tracked in BTMS Procedure posted on Web: 09/06/07 Hard Copy files updated: n/a Document Control: 09/065/07

Revision Log

Purpose: <input type="checkbox"/> Temporary Change <input type="checkbox"/> Change in Scope <input type="checkbox"/> Periodic review <input type="checkbox"/> Clarify/enhance procedural controls		
Changed resulting from: <input type="checkbox"/> Environmental impacts <input type="checkbox"/> Federal, State and/or Local requirements <input type="checkbox"/> Corrective/preventive actions to non-conformances <input type="checkbox"/> none of the above		
Section/page and Description of change:		
(signature/date on file) SME Reviewer/Date:	(signature/date on file) Reviewer/Date:	Reviewer/Date:

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Attachment 9.1

Sample of the Recommended Glove Material for common BNL laboratory chemicals from [Exhibit: BNL Handbook on Personal Protective Equipment \(PPE\) Selection and Use](#)

Recommended Glove Material for common BNL laboratory chemicals											
Chemical Name	Splash Protection (disposable, exam style)			Immersion & Sustained Contact							
	Nitrile (N-Dex, Purple Knight)	Natural Rubber (Latex Exam)	PVC	Disposable Nitrile (N-Dex) (unflocked and unsupported)						Reusable (typically flocked or fabric support)	
				DEGRADATION (MIN)				PERMEATION (MIN)			
				5	30	60	240	Break-thru time	Rate		
Acetonitrile	P	NR	NR	P	P	P	P	4		E= Butyl, Teflon, 4H	
Acetic anhydride	NR	NR	NR	NR	NR	NR	NR	NR	NR	E= butyl, Teflon, 4H	
ACIDS, dilute	E	F	F	E	E	E	E			Butyl, Nat Rubber, Neoprene, Nitrile, PVC, Teflon, Viton, 4H	
Hydrochloric Acid 37%	E	F	F	E	E	E	E	ND	ND	E= Butyl, Nat Rubber, Neoprene, Nitrile, PVC, Teflon, Viton, 4H	
Phosphoric Acid 85%	E	F								Butyl, Nat Rubber, Neoprene, Nitrile, PVC, Viton, 4H	
Nitric Acid 30-70%	G	NR								Butyl, Neoprene, Viton, 4H	
Nitric Red Fuming	NR	NR								Teflon	
Sulfuric Acid 97%	G	NR								Butyl, Teflon, 4H, Viton	
Acetic Acid 84%	E	F 14								Butyl, Neoprene, Viton, 4H	
ALKALI, dilute	G	F								Nat Rubber, Neoprene, Nitrile, PVC, Teflon, Viton, 4H	
Ammonium Hydroxide 30-70%	G	NR								Butyl, Neoprene, Nitrile, Teflon	
Potassium Hydroxide (KOH) 45%	E	F								Butyl, Nat Rubber, Neoprene, Nitrile, PVC, Teflon, Viton, 4H	
Sodium Hydroxide (NaOH) 50%	E	F								Butyl, Nat Rubber, Neoprene, Nitrile, PVC, Teflon, Viton, 4H	
ALCOHOLS	G	F								Nat Rubber, Neoprene, Nitrile, PVC, Teflon, Viton, 4H	
Ethanol	E	NR								Butyl, Neoprene, Viton, 4H; F= Nitrile	
Iso-propanol (2-propanol)	E	NR	F	E	E	E	E	15	25	E= Butyl, Neoprene, Nitrile, Teflon, Viton, 4H	
Methanol	E	NR	NR	E	G	G	F	NR	NR	E= Butyl, Neoprene, Nitrile, Teflon, Viton, 4H	
n-Propanol	G	NR	F	G	F	P	P	7	42	E= Butyl, Teflon, Viton, 4H	
ALDEHYDES											
Acetaldehyde	NR	NR	NR	NR	NR	NR	NR	NR	NR	E= Butyl, 4H, Teflon	
Benzaldehyde	NR	NR	NR	NR	NR	NR	NR	NR	NR	E= Butyl, PVA, Viton, 4H	
Formaldehyde	E	NR	F	E	E	E	E	ND	ND	E= Butyl, Nitrile, Viton, 4H	
Ammonia	NR	NT	NR	NR	NR	NR	NR	NR	NR	E= Butyl, Nitrile, Teflon, Viton	
AROMATICS	F	NR	NR	NR	NR	NR	NR	NR	NR	PVA, Viton, 4H	
Benzene	NR	NR	NR	NR	NR	NR	NR	NR	NR	E= PVA, Teflon, Viton, 4H	
Toluene	F	NR	NR	NR	NR	NR	NR	NR	NR	E= PVA, Teflon, Viton, 4H	
Xylene	F	NR	NR	NR	NR	NR	NR	NR	NR	E= PVA, Teflon, Viton, 4H	
CHLORINATED HYDROCARBONS	P	NR	NR	NR	NR	NR	NR	NR	NR	Butyl, Nitrile, PVA, Teflon, Viton, 4H	
Carbon tetrachloride	F	NR	NR	NR	NR	NR	NR	NR	NR	E= PVA, Viton, 4H	
Chloroform	P	NR	NR	NR	NR	NR	NR	NR	NR	E= PVA, Viton, 4H, Teflon	
Methylene Chloride (dichloromethane)	F	NR	NR	NR	NR	NR	NR	NR	NR	E= PVA, Teflon, 4H	
Trichloroethane, 1,1,1-	F	NR	NR	NR	NR	NR	NR	NR	NR	E= Butyl, PVA, Viton, 4H	

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Attachment 9.2

Sample of Online NIOSH Pocket Guide to Chemical Hazards

Acetic acid		CAS 64-19-7	
CH ₃ COOH		RTECS AF1225000	
Synonyms & Trade Names Acetic acid (aqueous), Ethanoic acid, Glacial acetic acid (pure compound), Methanecarboxylic acid [Note: Can be found in concentrations of 5-8% in vinegar.]		DOT ID & Guide 2790 153 (10-80% acid) 2789 132 (>80% acid)	
Exposure Limits	NIOSH REL: TWA 10 ppm (25 mg/m ³) ST 15 ppm (37 mg/m ³)		
	OSHA PEL: TWA 10 ppm (25 mg/m ³)		
IDLH 50 ppm See: 64197		Conversion 1 ppm = 2.46 mg/m ³	
Physical Description Colorless liquid or crystals with a sour, vinegar-like odor. [Note: Pure compound is a solid below 62°F. Often used in an aqueous solution.]			
MW: 60.1	BP: 244°F	FRZ: 62°F	Sol: Miscible
VP: 11 mmHg	IP: 10.66 eV		Sp.Gr: 1.05
Fl.P: 103°F	UFL: 2000°F (1000°C)	LF: 100°F	
Class II Combustible Liquid: Fl		<div>SAMPLE</div>	
Incompatibilities & Reactivity Strong oxidizers (especially chromates, permanganates, and persulfates.) Corrosive to			
Measurement Methods NIOSH 1603 ; OSHA ID186SG See: NMAM or OSHA Methods			
Personal Protection & Sanitation Skin: Prevent skin contact (>10%) Eyes: Prevent eye contact Wash skin: When contaminated (>10%) Remove: When wet or contaminated (>10%) Change: No recommendation Provide: Eyewash (>5%), Quick drench (>50%)		First Aid (See procedures) Eye: Irrigate immediately Skin: Water flush immediately Breathing: Respiratory support Swallow: Medical attention immediately	
PPE Recommendations NIOSH/OSHA Up to 50 ppm : (APF = 25) Any supplied-air PPE operated in a continuous-flow mode [†] /(APF = 25) Any powered,			

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air-purifying PPE with organic vapor cartridge(s)[†]/(APF = 50) Any chemical cartridge PPE with a full facepiece and organic vapor cartridge(s)/(APF = 50) Any air-purifying, full-facepiece PPE (gas mask) with a chin-style, front- or back-mounted organic vapor canister/(APF = 50) Any self-contained breathing apparatus with a full facepiece/(APF = 50) Any supplied-air PPE with a full facepiece

Emergency or planned entry into unknown concentrations or IDLH conditions: (APF = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode/(APF = 10,000) Any supplied-air PPE that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus

Escape: (APF = 50) Any air-purifying, full-facepiece PPE (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus

Exposure Routes inhalation, skin and/or eye contact

Symptoms Irritation eyes, skin, nose, throat; eye, skin burns; skin sensitization; dental erosion; black skin, hyperkeratosis; conjunctivitis, lacrimation (discharge of tears); pharyngeal edema, chronic bronchitis

Target Organs Eyes, skin, Respiratory system, teeth

See also: [INTRODUCTION](#) See ICSC CARD: [0363](#)

Non-Radiological CPE Selector Qualification Record

Job Performance Measure (JPM) Completion Certificate

Candidate's Name	Life Number:
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Practical Skill Evaluation: Demonstration of Evaluation Methodology

Criteria		Qualifying Performance Standard	Unsat.	Recov.	Satisf.
1.	Determining the need for selection	Demonstrates knowledge that the selection (prompted by worker's concern, line management requests, exposure monitoring data, or observation of other indicators) is valid in that : <ul style="list-style-type: none"> Engineering Controls and Admin Controls explored for feasibility Voluntary Use versus Mandatory versus Regulatory 			
2.	Conducts appropriate interviews	Demonstrates knowledge in conducting interviews with supervision and workers to determine exposure characteristics, patterns, and duration. Includes: <ul style="list-style-type: none"> Review of Work Planning & Control documents Health and Safety Plans Standard Operating Procedures, Skill of Craft Documentation/ PPE Matrix Tables 			
3.	Hazard Identification	Demonstrates knowledge to correctly determine and document the type of hazards, including: <ul style="list-style-type: none"> Describes types of health hazards from chemicals Implications of each type hazard on PPE selection Compounding of different hazard types (such as particulates and vapors, biological agents and disinfectants). Mixtures: Synergistic and Additive Effects 			
4.	Measurement of hazard	Knows how to properly measure employee exposure to hazardous airborne levels of chemical hazards, find existing exposure data, or extrapolate from representative data.			
5.	Other Hazards Contribution to exposure	Understands the potential of surface contamination, airborne levels of other contaminants hazards as contributors to total exposure. <ul style="list-style-type: none"> Influence on personnel exposure Influence on equipment and personnel decontamination 			
6.	Regulatory Compliance	Knows how to appropriately determine the effectiveness of different PPE types to satisfy <i>Permissible Exposure Limits</i> and <i>Threshold Limit Values®</i>			
7.	Equipment Selection	Knows the theory, advantages, disadvantages, and limitations to consider in selecting the PPE, including: <div> <div>1 Dexterity</div> <div>2 Tactility</div> <div>3 Grip</div> <div>4 Permeation</div> <div>5 Penetration</div> <div>6 Degradation</div> </div>			
8.	Equipment Selection	Knows sources of recommendations for PPE selection.			

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	Criteria	Qualifying Performance Standard	Unsat.	Recov.	Satisf.
9.	Operating Parameters	Knows the theory to establish operating parameters (safety envelope) for the PPE selected: <ul style="list-style-type: none"> • End of Service Life • Break-through time • Warming Properties 			
10.	Decontamination/ Storage	Knows the proper post exposure handling of the PPE selected: <ul style="list-style-type: none"> • Disposal • Decontamination • Disinfection • Storage 			
11.	Documentation	Demonstrates how to correctly obtain and fill out SBMS <i>Chemical Protective Clothing Selection Form</i> .			

Practical Skill Evaluation: Demonstration of Knowledge by Evaluation of a Case Study

	Criteria	Qualifying Performance Standard	Unsat.	Recov.	Satisf.
12.	Evaluation of a Hypothetical Exposure Scenario	Scenario Title: _____ First Score: _____ Retest Score: _____			

I accept the responsibility for performing this task as demonstrated within this JPM and the corresponding SOP.

Candidate Signature:	Date:
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I certify the candidate has satisfactorily performed each of the above listed steps and is capable of performing the task unsupervised.

Evaluator Signature:	Date:
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